REMARKS

I. Request for Information, 37 CFR § 1.105

In the Office Action dated May 22, 2007, the Examiner requested that in accordance with CFR § 1.105, the Applicant provide detailed test data, appropriate written description of the meaning of such test data including pictures of test setup to demonstrate that the claimed invention has been reduced to practice.

Applicant's invention relates to nanoconnections that are grown directly within the gap rather than at the electrodes. In order to demonstrate this feature of Applicant's invention and ultimately, Applicant's overall nanometer scale based device, consider the case of a charged nanoparticle suspended in a liquid dielectric solution between two electrodes. Applicant presents the following discussion to demonstrate that the nanoconnections formed in a solution and attracted to a connection gap (rather than electrodes) is based on practical principals and can function as a neural network. (Note: Applicant is, of course, not asserting that his nanoparticles must be charged, but just providing a helpful illustration). Consider that an <u>alternating</u> electric field is applied across the electrodes. Because the field is alternating, the charged particle is equally attracted and repelled to/from both electrodes. Nanoparticles are moved by a dipole induced force, e.g., the dielectrophoretic force. Such a force can be described mathematically as follows:

$$\vec{F}_{dep} = 2\pi r^3 \varepsilon_0 \varepsilon_m \mathrm{Re}\left[\frac{\varepsilon_p^* - \varepsilon_m^*}{\varepsilon_p^* + 2\varepsilon_m^*}\right]\nabla E^2$$

Note that the force is dependent on the <u>gradient</u> of the <u>square of the magnitude of the electric field</u>. It is standard physics knowledge that the electric field inside a conductor is zero. As soon as a conducting nanoparticle touches an

electrode there can be no electric field between the nanoparticle and the electrode because their electric potentials are equal. Thus, the moment the particle actually touches the electrode is the moment the dielectrophoretic force is in essence turned off. One can then argue that the particle was in fact attracted to the electrode gap and not the electrode.

In order to demonstrate these concepts, the Applicant refers to the following document, Hong et al. (which is included herewith). A figure from the Hong et al reference is shown below for the convenience of the Examiner:

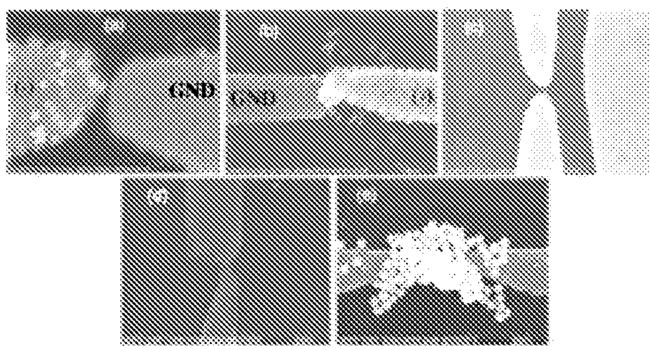

Fig. 2. (a) SEM image of captured Au nano-particles of diameter 20 nm under DC bias of - 2.05 V. (b) SEM image of captured Au nano-particles of diameter 40 nm under DC bias of - 3.3 V. (c) SEM image of captured Au nano-particles of diameter of 20 nm under AC bias of 1 V (peak-to-peak), 100 kHz, for 8 seconds. (d) SEM image of captured Au nano-particles of diameter 30 nm under AC bias of 4 V, 1 MHz for 40 seconds. (e) SEM image of captured Au nano-particles of diameter 50 nm under AC bias of 5 V, 1 MHz, for 300 seconds.

The Hong et al reference, which post dates this patent application, demonstrates that particles are attracted only to the electrode gap. One needs only compare Fig. 2(b) to Fig. 2(d) of the Hong et al reference. In Fig. 2(b) a non-alternating (i.e., static) voltage is applied across electrode terminals. Because the gold nanoparticles obtain a net positive charge when placed in solution, they are

attracted only to the negative electrode. Contrast this with the case shown by Fig. 2(d) of the Hong et al reference where the applied voltage is now alternating. Note how the particles are only attracted to the electrode gap and do not accumulate on either electrode. Fig. 2(e) shows what happens when the magnitude of the alternating voltage is increased by a volt and allowed to continue for 260 seconds longer. Note that the accumulation of particles is directed to the electrode gap. However, the abundance of particles requires that they necessarily touch the electrodes. It is very clear by these pictures that particles are attracted to the gap and not the electrodes themselves. The Hong reference does not use "colloidal chains" such as those discussed by the Examiner in the May 22, 2007. The use of colloidal chains and electroheological fluids is something completely different.

The Applicant respectfully encourages the Examiner to explore the field of negative dielectrophoresis whereby certain electrode geometries can be used to trap non-charged particles while never touching the electrodes. The Applicant also encourages the Examiner to explore the area of laser tweezers because both of these fields directly manipulate charge neutral particles without ever touching them with electrodes.

The Applicant submits that the submission of the Hong reference (which is not prior art, because it does not pre-date Applicant's invention) satisfies the Examiner's request for information under 37 CFR 1.105 in that the Hong reference shows that nanoconnections can be formed when subject to a dielectrophoretic force and are not formed in chain formations and/or in electroheological fluids or colloidal suspensions, but are instead attracted to a connection gap rather (rather than electrodes).

The Applicant additionally cites MPEP 2138.05 as follows:

2138.05 "Reduction to Practice" [R-5] - 2100 Patentability

Reduction to practice may be an actual reduction or a constructive reduction to practice which occurs when a patent application on the claimed invention is filed. The filing of a patent application serves as conception and constructive reduction to practice of the subject matter described in the application.

Thus the inventor need not provide evidence of either conception or actual reduction to practice when relying on the content of the patent application. *Hyatt v. Boone*, 146 F.3d 1348, 1352, 47 USPQ2d 1128, 1130 (Fed. Cir. 1998).

Thus, the filing of Applicant's patent application is evidence of a reduction to practice, being a constructive reduction to practice. However, the Hong reference cited herein and included with this response provides evidence that nanoconnections can be formed in a solution and attracted to a connection gap (rather than electrodes) to form such connections.

Additional evidence of an actual physical neural network is disclosed in U.S. Patent No. 6,889,216, which issued to the Applicant on May 3, 2005. For the convenience of the Examiner, U.S. Patent No. 6,889,216 is also included herewith. The Applicant submits that the combination of the Hong reference and U.S. Patent No. 6,889,216 provides evidence of a physical neural network consistent with Applicant's claimed invention.

Applicant submits that the foregoing satisfies the reply required under 37 CFR 1.105.

II. Prior Art Anticipation

In the Office Action dated May 22, 2007, the Examiner provided a discussion of "Prior Art Anticipation". The Examiner, however, did not indicate under which specific section of 35 U.S.C 102 (a, b, c, d, etc?) this discussion relates. The Examiner argued that Applicant's concept of a liquid dielectric solution comprising a mixture of a plurality of nanoconductors and a liquid dielectric solvent wherein a plurality of nanoconductors are free to move about in a dielectric solution and such solution is disposed between two electrodes is anticipated by Paul M. Adriani and Alice P. Gast in the article entitled "Electric-field-induced aggregation in dilute colloidal suspensions" (hereinafter referred to as Adriani) published in 1990 by the Faraday Discussions of the Chemical Society. The abstract is cited as follows:

Electric-field-induced chain formation in dilute, non-aqueous suspensions of sterically stabilized, 1 μm poly (methyl methacrylate) (PMMMA) lattices are investigated. Optical microscopy and digital image analysis provide the chain-length distribution. We find that the particles carry a charge sufficient to inhibit field-induced aggregation. Equilibrium predictions of chain aggregation incorporating a screened Coulombic repulsion and field-induced dipole attraction agree with experimental observations near the onset of aggregation; chain formation becomes diffusion limited above the threshold field strength.

The Applicant respectfully disagrees with this assessment. The abstract and reference cited by the Examiner relates to the formation of "chains" in non-aqueous suspensions. Applicant is not developing electric-field induced chain formations. A "chain" implies direct connections between the colloidal particles as described in the Adriani paper. A chain is a series of things depending on each other as if linked together. Applicant's invention, on the other hand, relates to an adaptive synaptic element comprising a plurality of nanoconductors suspended and free to move about in a liquid dielectric solution located within a connection gap formed between at least one pre-synaptic electrode and at least one post-synaptic electrode. Thus, Applicant's invention does not rely on the use of a "chain" but is instead composed of nanoconductors that are suspended and free to move in the dielectric solution and not subject to a chain formation as is the case with the Adriani reference. Additionally, Adriani teaches the use of electroheological fluids, which are not dielectric solutions. Additionally, there is no teaching in Adriani of any type of a neural network or neural network components such as synapses. Also, Applicant's invention does not rely up on colloidal suspensions. In fact, the use of a colloidal suspension would be detrimental to the workings of Applicant's invention due to the fact that colloidal particles in colloidal suspensions are typically not on the nanometer scale.

The Examiner further asserted that Related to terminology, Applicant has not defined the term Nanotechnology. The Examiner cites From the web @ www.answers.com/nanotechnology, the following definition: Nanotechnology: the science and technology of building devices, such as electronic circuits, from single atoms and molecules.

The Examiner referred to the Nanotechnology web site created by Dr. Ralph Merkle, the statement is made that the "word nanotechnology has become very popular and is used to describe many types of research where characteristic dimensions are less than about 1,000 nanometers" (micron range). http:www.zyvex.com.nano/.

The Examiner argued that the Applicant has not defined "nanotechnology" related to a specific numeric scale. The Examiner cited Applicant's specification regarding size comparison @ specification, page 6, lines 15-18:

> Microelectrical nano-size components include transistors, resistors, capacitors and other nano-integrated circuit components. MEMS devices include, for example, micro -sensors, micro-actuators, microinstruments, micro-optics, and the like.

The Examiner argued that the Applicant indicated that such definition is entirely consistent with the above cited definitions/intent.

The Applicant respectfully disagrees with this assessment. The Applicant has defined "nanotechnology" related to a specific scale. See Paragraph [0016] of Applicant's specification, which indicates the following:

> The term "Nanotechnology" generally refers to <u>nanometer</u>-scale manufacturing processes, materials and devices, as associated with, for example, <u>nanometer</u>-scale lithography and <u>nanometer</u>-scale information storage.

Thus nanotechnology is something that must be at least on the nanometer scale. Adriani is not a nanotechnology reference as there is no teaching of "nanometer-scale" components and devices. In fact, Page 23, Paragraph 5, Lines 1-2 of Paragraph 5, of the Adriani reference specification indicates the following dimensions:

> "We measure suspension conductivity...in a stainless steel Couette cell of a 13 mm cylinder with a 12 mm radius and a gap of ca. 0.5 mm"

This is not a nanometer-scale device. Instead these dimensions (millimeters) are much larger. Thus, Adriani is not a nanotechnology-based device. For these reasons (e.g., Adriani is not nanotechnology, electroheological fluids are not

dielectric in nature, no teaching or hint in Adriani of neural networks, synapses, etc), Adriani does not anticipate Applicant's invention.

The Examiner further stated that related to terminology, Applicant refers to a solvent in the generic sense in the specification, page 25, ¶ 0099, that includes a condition of suspension.

Related to terminology, the Examiner also asserted that the Applicant refers to a liquid dielectric solution without any explicit definition of dielectric. The Examiner argued that dielectric means, to one of ordinary skill in the art, a non-conducting or insulating substance which resists passage of electric current, allowing electrostatic induction to act across it. The Examiner argued that a liquid dielectric solution will inherently have an electric conductance that is less than that when the subject solution has conducting material suspended in it such as the claimed nanoconductors.

The Applicant cited Adriani, the following on page 20, line 1:

> Particles having aligned dipoles will aggregate into chains.

The Applicant again submits that the use of dipoles aggregated into chains is not a feature of Applicant's invention and in fact would not function in the context of Applicant's invention, because Applicant's nanometer scale nanoconductors do not form chains or links as is the case with the Adriani reference. Instead, Applicant's invention provides for nanometer scale nanoconductors that are disposed and free to move about in the dielectric solution, not chained to one another, even after application of an electric field.

The Examiner further argued that Mehrotra et al. in Elements of Artificial Neural Networks cites the nature of neural networks to include a feed forward neural network in Figure 1.15 on page 20; the adaptive linear element of Figure 2.8 with weight adjustments into a summation circuit with a training algorithm identified in Figure 2.9 on page 59. The Examiner asserted that Mehrotra, among others, assert neural networks with layers of nodes feeding with a plurality of

connections into a plurality of nodes at the next layer. Applicant notes that Mehrotra provides no teaching whatsoever of nanotechnology based devices. In fact Mehrotra provides only for a teaching of software-based neural network solutions, not actual physical artificial neural networks. For example, page 46, section 2.3 of Mehrotra provides for a detailed discussion of a "perceptron training algorithm". An algorithm is not "physical" but is instead a mathematical and hence software construct. One skilled in the art would not look to Mehrotra for a teaching of a nanometer-scale physical neural network device. Mehrotra is simply one of many references dealing with software-based neural network solutions. Applicant's solution overcomes the problems with software/algorithm neural networks. There is a discussion of software-based problems in Applicant's specification so there is no need to repeat that here.

The Examiner also referred to Therese C. Jordan et al. writing in 1989 in the IEEE, Entitled "Electrorheology" in order to cite a graphic illustration of dipole arrangement in the presence of an electric field in figure 16. on page 867 which was copied from an article published in 1978 by H>A> Pohl, entitled: Dielectrophoresis: The behavior of neural matter in nonuniform fields. The Examiner argued that arrangements follow dipole to dipole aligned to the field between the electrodes. The Examiner also argued that there is no evidence of dipoles forming nodes and dipoles crossing from one chain to other chains as is required in the formation of neural networks. (Note: Applicant does not form chains). The Examiner also argued that, in the cited Coulombic repulsion, such repulsion will prevent extension of dipoles. (Note: Applicant does not use Coulombic repulsion) The Examiner further argued that there is no formation of chains to form weights to adjust values at a given node. (Note: Again, Applicant does not form chains).

The Applicant notes that these arguments are not correct, particularly given the evidence provided by the Hong et al reference included herewith.

The Examiner argued that the evidence shown in the cited papers demonstrates that the concept disclosed by the applicant and cited below will not function as a neural network. The Applicant submits that this is incorrect as the Hong reference demonstrates that nanoconnections can be formed in dielectric solutions. The connections of the Hong reference could modified for use in forming a neural network, which is a discovery first realized by the Applicant.

Based on the foregoing, the Applicant submits that the Adriani et al. and Jordan et al. references do not liquid state anticipated equivalents of Applicant's electromechanical-based liquid state machine Applicant's invention is not based on the use of "chains". The Examiner has not conclusively established that the invention of the Applicant will simply not function as a neural network.

III. Claims Rejections 35 U.S.C. § 101

The Examiner rejected claims 24-44 under 35 U.S.C. 101, arguing that the claimed invention lacks patentable utility. The Examiner argued that the neural network that is claimed cannot develop and the whatever network that may develop, cannot function as a neural network because it is not a neural network ... chains are not neural networks. The Applicant respectfully disagrees with this assessment. Applicant does not use "chains" and the Hong reference demonstrates connections that could be adapted for use in a neural network by applying Applicant's claimed invention. Applicant's invention does provide patentable utility...what is more "utilitarian" than a nanometer-scale physical neural network? Applicant's specification indicates that the physical neural network of Applicant's invention would be much faster than any present software-based neural network solutions. Regarding utility, Applicant's specification provides many examples of utility. FIGS. 14-18 of Applicant's specification, for example, describe a chip-implementation of Applicant's invention. This constitutes one example a practical application for practicing Applicant's invention, particularly in light of the features demonstrated by the Hong reference.

Based on the foregoing, Applicant respectfully requests that the rejections under 35 U.S.C. 101 be withdrawn.

IV. Claims Rejections 35 U.S.C. § 112

The Examiner rejected Claims 24-44 under 35 USC 112, first paragraph by arguing that current case law (and accordingly, the MPEP) require such a rejection if a 101 rejection is given because when Applicant has not in fact disclosed the practical application for the invention, as a matter of law there is no way Applicant could have disclosed how to practice the undisclosed practical application.

The Applicant respectfully disagrees with this assessment. As indicated previously, Applicant does not use "chains" and the Hong reference demonstrates connections that could be adapted for use in a neural network by applying Applicant's claimed invention. Applicant's invention does provide patentable utility...what is more "utilitarian" than a nanometer-scale physical neural network? Applicant's specification indicates that the physical neural network of Applicant's invention would be much faster than any present software-based neural network solutions. Regarding utility, Applicant's specification provides many examples of utility. FIGS. 14-18 of Applicant's specification, for example, describe a chip-implementation of Applicant's invention. This constitutes one example a practical application for practicing Applicant's invention, particularly in light of the features demonstrated by the Hong reference.

Based on the foregoing, Applicant respectfully requests that the rejections under 35 U.S.C. 112 be withdrawn.

V. Claims Rejections, 35 U.S.C. § 102 / § 103

The Examiner argued that claims 24-44 fail to identify an invention (neural network) that can be evaluated under the conditions of novelty or nonobviousness. The Examiner argued that the approach taken using nanoconductors fails to produce a neural network. The Examiner also asserted that the claims as written have no basis in reality and cannot be evaluated because the invention doesn't and cannot exist. The Examiner further argued that if the Applicant is not claiming a neural network, then the chains of Adriani and the dipoles of Jordan anticipate the applicant's invention. The Applicant respectfully disagrees with this assessment. Applicant has identified an invention that can be evaluated under the conditions of novelty or nonobviousness. The approach taken by Applicant can provide for a neural network. Applicant's specification and the Hong reference provide sufficient evidence to make this point. Applicant's invention does have a basis in reality (i.e., see Hong reference for forming connections in a gap). Additionally, as indicated previously, neither Adrianai nor Jordan anticipate Applicant's invention and further, Applicant's invention does not form chains nor utilize such "chains".

VI. Conclusion

The Applicant has clarified the structural distinctions of the present invention via the amendments submitted herewith. Such amendments are enabled and support by Applicant's specification and do not constitute new matter. Reconsideration and allowance of Applicant's application is therefore respectfully solicited.

Should there be any outstanding matters that need to be resolved, the Examiner is respectfully requested to contact the undersigned representative to conduct a telephonic interview with the Applicant (Alex Nugent) in an effort to expedite prosecution in connection with the present application.

Respectfully submitted,

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